INTRODUCTION

EnSight provides a powerful capability to derive new variables from existing variables and parts. For example, in a fluids dynamics problem, if you have momentum, density, and stagnation energy you can calculate temperature, Mach number, pressure, or velocity. In addition to the built-in functions, you can also compose your own functions using the equation editor in conjunction with previously defined variables.

This article is divided into the following sections:

BASIC OPERATION

Introduction

EnSight provides five distinct types of variables:

Constant	A constant variable is a single value. Constants do not vary across a part although a constant can vary over time. Examples include Analysis_Time, Temperature[123] (the value of temperature at node 123), Stress{3}[321] (the value of stress at node 321 at time step 3), or the value of a function that produces a constant (*e.g.* Area).
Scalar	A scalar variable is a set of values: one for each node or element of the applicable part(s). Examples include Pressure, Velocity[Z] (the Z component of velocity), Stress{3} (the value of stress at time step 3), or the value of a function that produces a scalar (*e.g.* Flow)
Vector	A vector variable is a set of values: three (the X,Y,Z components) for each node or element of the applicable part(s). Examples include Velocity, Velocity{3} (the value of velocity at time step 3), Coordinates (a given variable equal to the XYZ coordinate at a node), or the value of a function that produces a vector (*e.g.* Vorticity).
Tensor	A tensor variable is a set of values: six (if symmetric) or nine (if asymmetric), for each node or element of the applicable part(s). Tensor variables can be represented by Tensor Glyphs directly, and within the variable calculator eigenvalues, eigenvectors, determinant, VonMises or Tresca, etc. can be computed.
Complex	A complex variable, which within Ensight can be either scalar or vector, includes the real and imaginary portions of the values. The variable calculator allows the user to compute things like modulus, argument, transient response, etc.

Variables are either *given* (read from the dataset or automatically provided by EnSight) or *computed* (derived from existing variables during an EnSight session). The variable type and whether it is given (shown as “Gvn”) or computed (shown as “Cmp”) are shown in the Variables list in the Feature Detail Editor for Variables. If you have any element-based variables in a model, the variable names in the Main Variables list will be preceded by “(E)” for element-based or “(N)” for node-based.

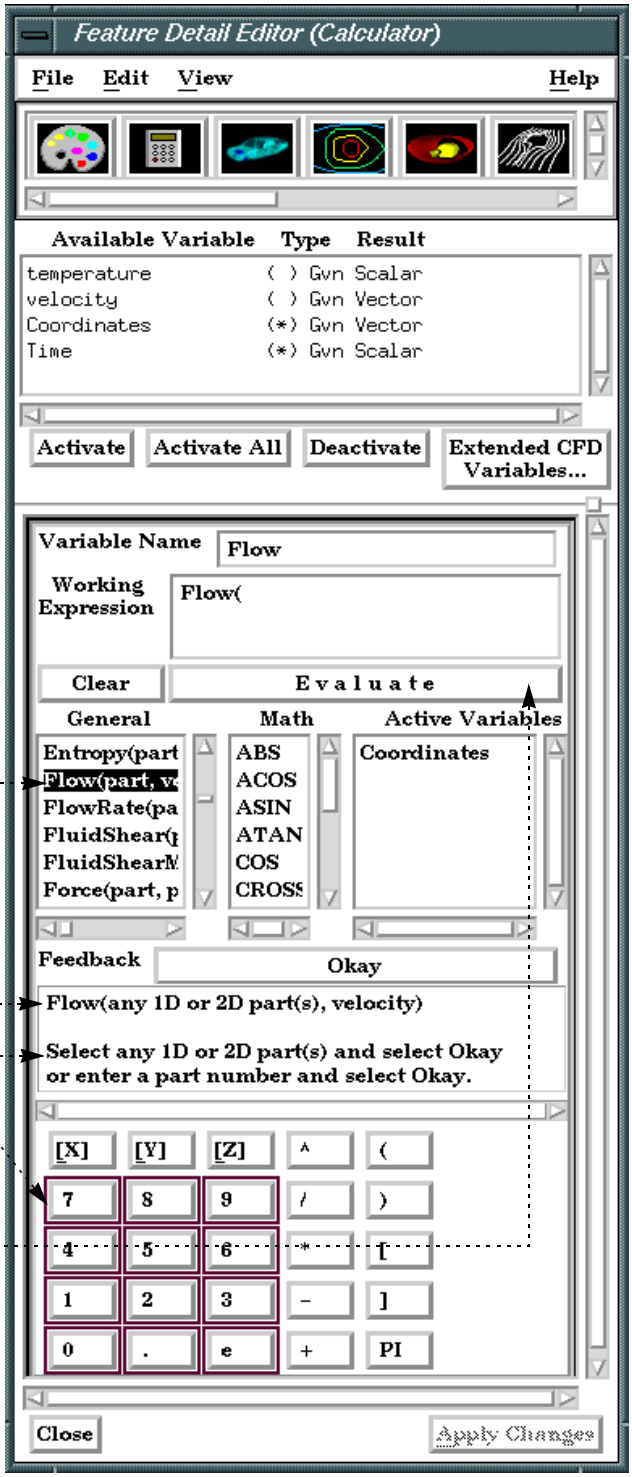
Every non-constant variable (both given as well as computed) has an associated color palette that defines the mapping from variable values to color. These palettes can be edited to change the mapping (see **How To Edit Color Maps** for details). The value of a constant variable can be displayed as a text string in the Graphics Window (see **How To Create Text Annotation** for details).

For time-dependent data, calculated variables will automatically recalculate when the current time step is changed.

Variable Creation

Derived variables are easily created using the **Feature Detail Editor Variable Calculator**. To create new variables:

1. **Double-click the Variable Calculator icon in the Feature Icon bar to open the Feature Detail Editor (Calculator).**



3. **Select the desired function from the General list or the Math list.**

When you select a function, the Variable Name field (at the top of the section) is loaded with the name of the function. This will be the name of the variable as seen in the Main Variables list. You can change this name by entering a new value (and pressing return).

A description of the function parameters appears in the feedback section, as well as instructions for properly composing the required parameters.

The expression is built in the Working Expression section. As you insert parameters, they are automatically added to the expression and the instructions for the next parameter will appear. Parameters can be inserted as follows:

Parts: by selecting the desired part(s) in the Main Parts list (and clicking Okay) or by entering the part number directly in the Working Expression area. Note that the place holder “plist” appears in the expression denoting the list of currently selected parts.

Variables: by clicking on the desired variable in the Active Variables list.

Constants/other: by typing the desired constant or other text directly into the Working Expression or by clicking the desired item in the Calculator keypad.

4. **Follow the instructions to build the desired expression and then click Evaluate.**

Examples of Expressions

The following examples demonstrate usage of the variable calculator. In each case, first enter a name in the Variable Name field and click in the Working Expression area to activate it. The examples assume that Analysis_Time (a given constant variable if the dataset is transient), pressure, density, and velocity are all given variables.

Expression	Description and How to Build
`-13.5/3.5`	A simple constant. To build, either type the text on the keyboard or click in the Calculator keypad.
`Analysis_Time/60.0`	A constant variable. Assuming the solution time was given in seconds, this expression will provide a variable giving the time in minutes. To build, select `Analysis_Time` from the Active Variable list and either type or click `/60.0`.
`velocity*density`	Momemtum – a vector variable. To build, select `velocity` from the Active Variable list, click or type `*`, and select `density` from the Active Variable list.
`SQRT(pressure[73]*2.5) + velocity[X][73]`	Square root of (`pressure` at node 73 * 2.5 + the X component of `velocity` at node 73) To build, select `SQRT` from the Math function list, select `pressure` from the Active Variable list, click or type `[73]*2.5`)+, select `velocity` from the Active Variable list, and click or type `[X][73]`.
`pressure{19}`	Scalar variable equal to `pressure` at time 19. This variable *will not* change if the current time step is changed. To build, select `pressure` from the Active Variable list and click or type `{19}`.
`MAX(plist, pressure)`	Constant variable equal to the maximum value for `pressure` over all nodes of all parts in `plist`. To build, select `MAX` from the General function list and follow the instructions in the Feedback area.
`(pressure/max_pres)^2`	Scalar variable equal to squared normalized `pressure`. To build, first calculate the `MAX` constant variable as described in the preceding example (here named `max_pres`). Click or type `(`, select `pressure` from the Active Variable list, click or type `/`, select `max_pres` from the Active Variable list, and click or type `)^2`.

Built-in Function Reference

Although all built-in functions are listed here, consult the **User Manual** for the complete definition of a function. EnSight provides the following built-in general variable calculation functions:

Function	Abbreviation (if any)	Description
Area		Surface area
Case Map	CaseMap	Map values of a variable from one case onto the nodes of another case.
Coefficient	Coeff	Coefficient
Complex	Cmplx	Create complex variable from variables representing the real and imaginary portions.
Complex Argument	CmplxArg	Argument of complex variable
Complex Conjugate	CmplxConj	Conjugate of complex variable
Complex Imaginary	CmplxImag	Imaginary portion of complex variable
Complex Modulus	CmplxModu	Modulus of complex variable
Complex Real	CmplxReal	Real portion of complex variable
Complex Transient Response	CmplxTransResp	Complex transient response
Curl		Curl of a vector
Density		Density
Divergence	Div	Divergence
Dynamic Pressure	PresDynam	
Element to Node	ElemToNode	Make a node-based variable from an element-based variable (via average)
Energy, Total	EnergyT	Total Energy

Function	Abbreviation (if any)	Description
Enthalpy		
Entropy		
Flow		Integrated flow through 1D/2D part
Flow Rate	FlowRate	
Fluid Shear Stress	FluidShear	Fluid shear stress
Fluid Shear Stress Max	FluidShearMax	Max of fluid shear stress
Force		Force Vector
Force, on 1D part	Force1D	Force Vector on 1D part
Gradient	Grad	3D gradient of a variable
Gradient Approximation	GradApprox	Linear, closed-form gradient approximation
Gradient Tensor	GradTensor	3D tensor gradient
Gradient Tensor Approximation	GradTensorApprox	Linear, closed-form tensor gradient approximation
Helicity Density	HelicityDensity	
Helicity Relative	HelicityRelative	
Helicity Relative Filtered	HelicityRelFilter	
Iblanking Values	IblankingValues	Scalar that is the iblanking flag per node
Kinetic Energy	KinEn	Kinetic energy
Length		Summed length of all 1D elements
Line Integral	IntegralLine	Integral over 1D elements
Log of Normalized Density	DensityLogNorm	
Log of Normalized Pressure	PresLogNorm	
Log of Normalized Temperature	TemperLogNorm	
Mach Number		Mach number
Make Scalar at Elements	MakeScalElem	Scalar created, by placing a constant value at each element
Make Scalar at Nodes	MakeScalNode	Scalar created, by placing a constant value at each node
Make Vector	MakeVect	Build a vector variable from scalars
Massed Particle	MassedParticle	Massed particle scalar
Mass Flux Average	MassFluxAvg	
Maximum	Max	Find max of variable over part(s)
Minimum	Min	Find min of variable over part(s)
Moment		Moment component of a force component based on the current position of the Cursor Tool. This is a constant.
Moment Vector	MomentVector	Moment component of a force component at each node of selected parts. This is a field of vectors.
Momentum	Momentum	
Node To Element	NodeToElem	Make an element-based variable from node-based (via average)
Normal		Surface normal vector
Normal Constraints	NormC	NC
Normalized Density	DensityNorm	
Normalized Enthalpy	EnthalpyNorm	
Normalized Pressure	PresNorm	
Normalized Stagnation Density	DensityNormStag	
Normalized Stagnation Enthalpy	EnthalpyNormStag	
Normalized Stagnation Pressure	PresNormStag	
Normalized Stagnation Temp.	TemperNormStag	
Normalized Temperature	TemperNorm	
Normalized Vector	NormalizeVector	Vector field expressed as unit vectors.

Function	Abbreviation (if any)	Description
Offset Variable	OffsetVar	Variable Value that exists offset from the boundary of the part into the field
Pitot Pressure	PresPito	
Pitot Pressure Ratio	PresPitoRatio	
Pressure	Pres	Pressure
Pressure Coefficient	PresCoef	
Rectangular To Cylindrical Vector	RectToCyl	Calculate vector in cylindrical coordinates
Shock Plot3d	ShockPlot3d	
Sonic Speed	SonicSpeed	
Spatial Mean	SpaMean	Mean of a variable over a part
Speed		Magnitude of velocity
Stagnation Density	DensityStag	
Stagnation Enthalpy	EnthalpyStag	
Stagnation Pressure	PresStag	
Stagnation Pressure Coefficient	PresStagCoef	
Stagnation Temperature	TemperStag	
Stream Function	Stream	Stream
Surface Integral	IntegralSurface	Integral over 2D elements
Swirl	Swirl	
Temperature		Temperature
Temporal Mean	TempMean	Mean of a variable over time
Tensor Component	TensorComponent	Component of a tensor variable
Tensor Determinant	TensorDeterminant	Determinant of a tensor variable
Tensor Eigenvalue	TensorEigenvalue	Eigenvalue of a tensor
Tensor Eigenvector	TensorEigenvector	Eigenvector of a tensor
Tensor Make	TensorMake	Make tensor from variables representing components
Tensor Tresca	TensorTresca	Tresca failure theory of a tensor
Tensor Von Mises	TensorVonMises	Von Mises failure theory of a tensor
Total Pressure	TPres	Total pressure
Velocity	Velo	Momentum/density
Volume	Vol	Volume of 3D elements
Volume Integral	IntegralVolume	Integral over 3D elements
Vorticity	Vort	Vorticity

The following standard math functions are also available:

Function	Abbreviation
Absolute Value	ABS
Arccosine	ACOS
Arcsine	ASIN
Arctangent	ATAN
Cosine	COS
Cross Product	CROSS
Dot Product	DOT
Exponent	EXP
Greater Than	GT

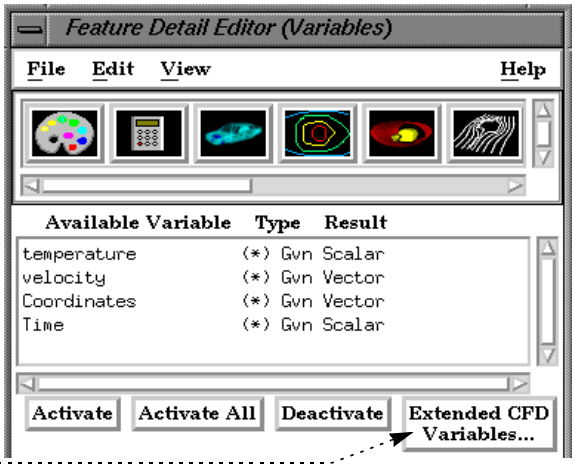
Function	Abbreviation
Less Than	LT
Log Natural	LOG
Log Base 10	LOG10
Root Mean Squared	RMS
Round	RND
Sine	SIN
Square Root	SQRT
Tangent	TAN

For information on the arguments (and equations), see General Functions or Math Functions in the User Manual.

Extended CFD Variables

Rather than having to individually create the various common CFD variables, EnSight can automatically make them available for use if the appropriate basis variables and constants have been provided. This can be accomplished after loading the model with the Extended CFD Variable Settings Dialog:

1. **From either the Variable or the Calculator Feature Detail Editor, click the Extended CFD Variables... button.**

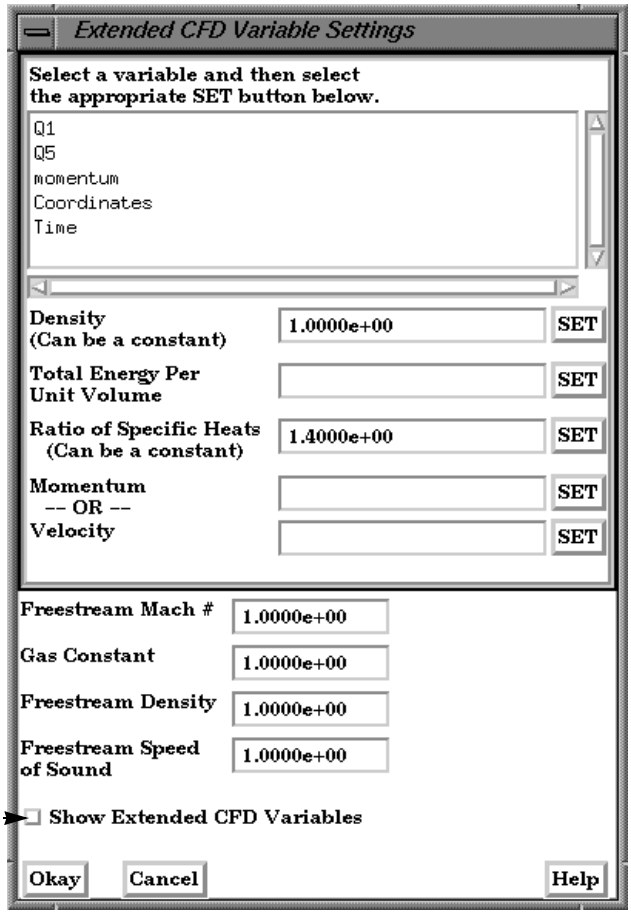


2. **Select the variable name in the list and then click the appropriate SET button.**

For example, select Q1 in the list and then click the SET button to right of the Density field.

3. **After all variables and constants have been specified, click Show Extended CFD Variables.**

4. **Click Okay.**



The common CFD variables will now be listed in the main variables list. Note that they will NOT actually be computed until activated.

If you have a "standard" PLOT3D Q file, the above process can be accomplished automatically by starting EnSight with the "`-cfd`" option on the command line.

See Also

How to Edit Color Maps

User Manual: **Variable Creation**